

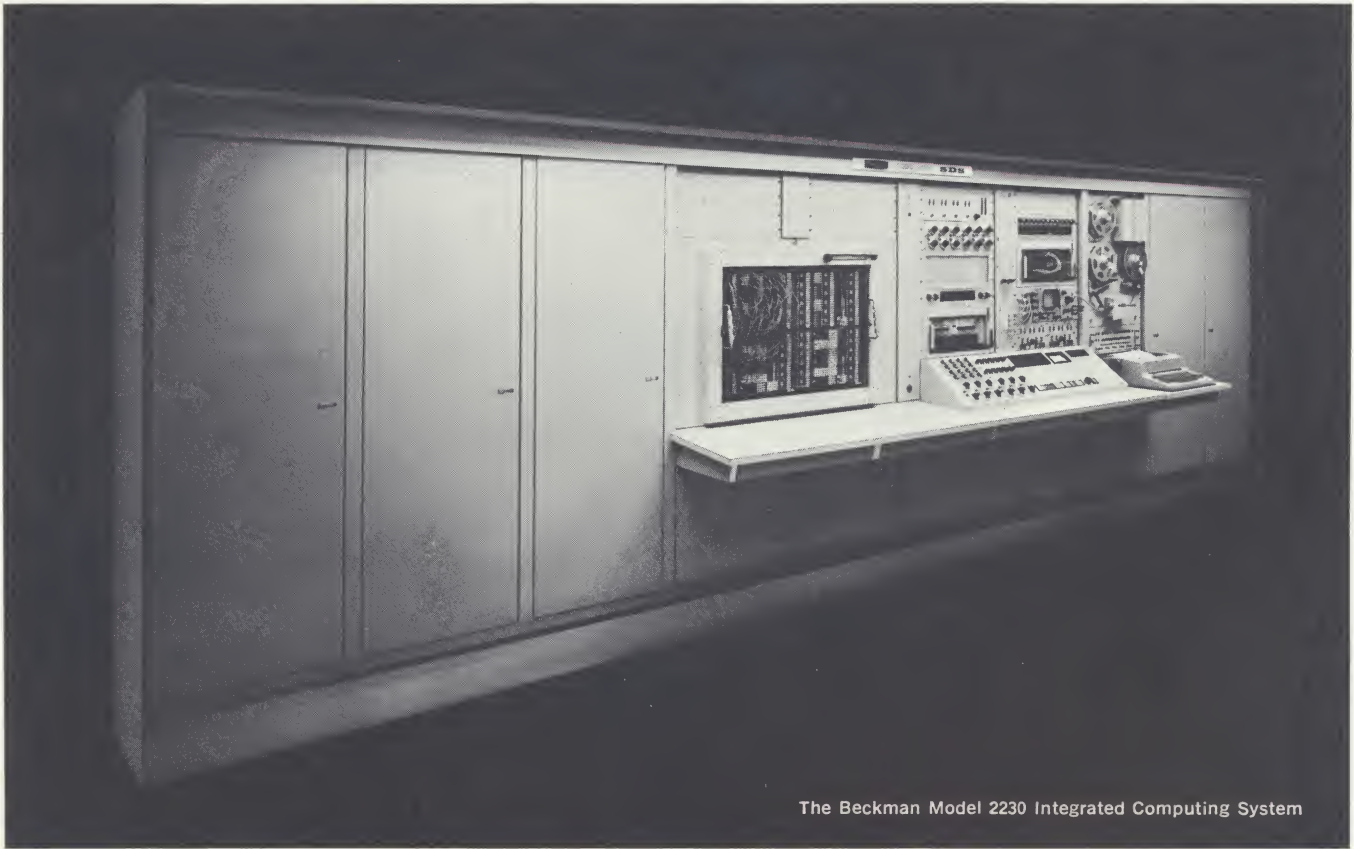
BECKMAN® / INTEGRATED COMPUTING SYSTEMS



Beckman

COMPUTER OPERATIONS

Problem Solving Power Through Total System Capability



The Beckman Model 2230 Integrated Computing System

THE BECKMAN APPROACH IN HYBRID COMPUTATION

The Beckman Integrated Computing System answers the demand! It offers you "problem solving power" through total system capability. Beckman accomplishes this through standard integrated hardware and software, developed by technological know-how that has long assured professional satisfaction within the industry.

HARDWARE

Beckman Instruments, Inc., and Scientific Data Systems, combining their broad experience in analog and digital computation, now offer you the first standard series of hybrid computers available. This allows you to choose from any six standard, all-solid-state systems to meet your particular needs. The all-important linkage or interface, which insures optimum flow of data and control information, is *standard*; therefore, there are no extra engineering or development costs.

SOFTWARE

Beckman hybrid software is designed to simplify programming and enable the user to easily determine the most effective use of the computer — without his acquiring an intimate knowledge of the hardware involved. Beckman

offers you the first standard software packages specifically designed for hybrid computation. With all Beckman Integrated Computing Systems — regardless of size — you are furnished a complete *standard* library of hybrid software at no extra cost. And because of the continuing software development by Beckman, you are assured of an up-to-date, ever growing library — again at no extra cost!

PLUS:

A complete operational software package is delivered with each system. Hybrid compilers, assemblers, maintenance and diagnostic programs, as well as a complete library of mathematical and utility routines are provided at no cost.

The Beckman Computation Center offers new software developments, hybrid training courses, and application engineering assistance to all Beckman users.

With built-in expansion capabilities in both hardware and software, your Beckman integrated computing system can be economically expanded to satisfy your growing computational needs.

Beckman warranty and service, unequalled in the industry, provide total system responsibilities from your initial acquisition of a Beckman integrated computing system, through installation and field service after delivery. All the resources and reputation of Beckman Instruments, Inc., guarantee you our responsible performance.

ANALOG SUBSYSTEMS

The Beckman Integrated Computing Systems incorporate the most advanced analog subsystem available — the Beckman Model 2230 general-purpose analog computer. This totally new and completely solid-state analog computer was specifically designed for integrated operation.

All solid-state linear and nonlinear equipment is designed to insure exceptional static and dynamic performance characteristics. Only one basic

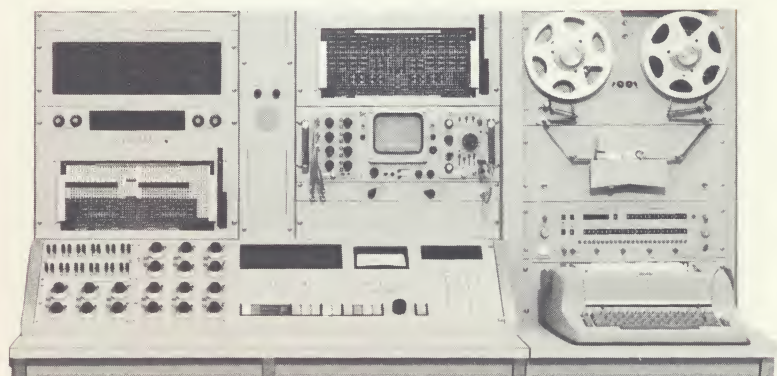
type of amplifier is used throughout the system, minimizing spare parts and service requirements. Dither-free sine-cosine generators provide full rate resolution capabilities. Function generators are offered either in compact, easily accessible manual-set units or digitally controlled types which can be rapidly set by the digital subsystem. In addition you have the choice of either, or both, solid-state and reed-relay switching.

CONSOLE

Through the use of newly designed patchboards, the analog and digital subsystem control console offers optimum flexibility and convenience for the operator. All controls are functionally grouped to simplify the operators command of the problem.

The use of the control patchboard eliminates the need for control wiring on the Analog Patchboard for use where they are needed; namely, the interconnection of problem voltages.

This design approach results in many additional advantages. The layout of the analog patchboard is not compromised by including control terminals. This results in an increase of up to 50% in linear equipment (amplifiers and potentiometers) available on the control console. A logic patchboard is available as an option.



ANALOG PATCHBOARD

The fully shielded removable analog patchboard has a 3,600-terminal capacity and is organized for the most efficient use of the analog computing elements. The patchboard consists of four quadrants of diallyl phthalate, bonded to brass plates. The patchboards are constructed such that, when inserted in the patchboard, the cord shields contact the brass plate. This construction affords a shield over the entire patchboard against interference or electrical noise.

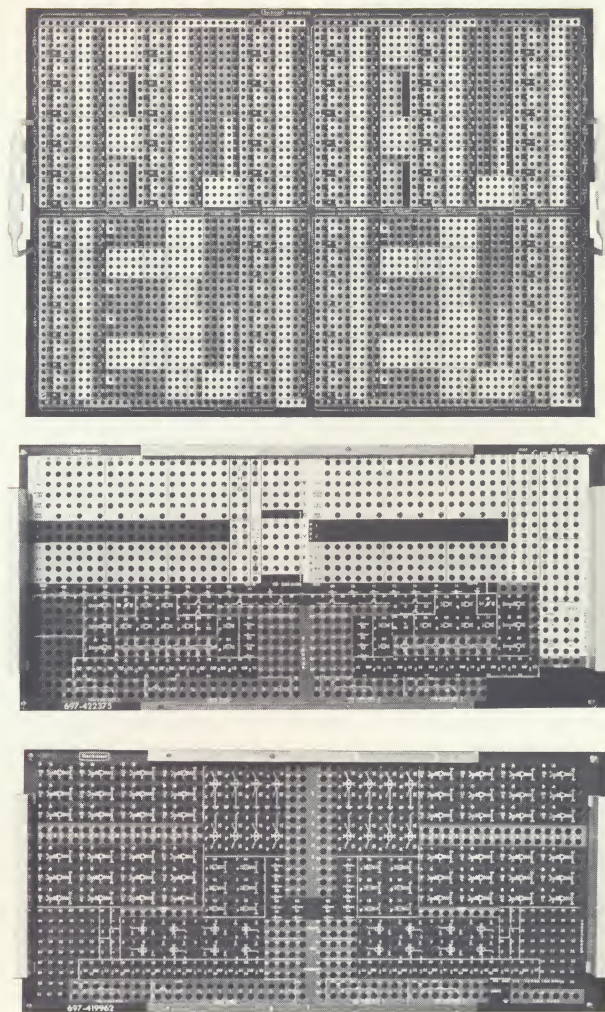
Entire problem signal interconnections are set up on the patchboard. These connections, to various components and functional component groups, are represented on the patchboard by blocks or designated areas of holes. Inputs, outputs, and control signals to functional components each have separate holes. When patching a mechanization, the output of one functional component is patched into an input of another functional group. Circuit configurations of individual components are established by patching within the appropriate block. Various terminals are color-coded in accordance with their individual connections, with various abbreviations describing function or ultimate connection of the terminal.

CONTROL PATCHBOARD

The control patchboard's basic function is to select the proper computer configuration required for a particular problem. It provides the means of controlling the circuits of the computing elements, such as hot-pinning/patching during the problem checkout phase, storage of the entire board for problem re-entry, and prepinning/patching for problem preparation independent of the computer. The control patchboard permits the operator to establish the type of computation required through transference selection, keeping all control wiring isolated from signal patching. (Analog Patchboard). You can quickly change an operational amplifier from a summer to integrator or high-gain amplifier without disturbing the analog patchboard. It also provides access to digital logic circuits located in the control patchbay. These digital circuits may be used in solving complex problems or whenever logic levels are desired.

LOGIC PATCHBOARD (OPTIONAL)

To satisfy the most complex computations, patchable digital logic is available as an option. Flip-flops, electronic switches, function relays, and comparators permit you to quickly modify a control function, such as two different operating cycles or change parameters. The quantity of the logic equipment in the system may be expanded at any time through the addition of this logic patchboard which provides greater problem flexibility.



INTERFACE SUBSYSTEM

The interface subsystem provides the two major paths of communication between the computer subsystems: the data channels and the control linkage. The data channels provide analog inputs and outputs to and from the digital subsystem, permitting the digital subsystem to exchange data and perform calculations on analog data and vice versa. The control linkage allows digital control of analog operations and communicates "sense" and "interrupt" information (originating in the analog) to the digital subsystem.

The digital subsystem with its arithmetic and decision-making capabilities performs hardware validations, calculations, sets up, and checks initial conditions. During computation it controls modes and may even alter the problem configuration while calculating and introducing new problem parameters as needed. In addition, data channels and control linkage can be used for communication with physical models, such as cockpit simulators.

DATA CHANNELS

DIGITAL-TO-ANALOG DATA CHANNELS

Fourteen-bit (plus sign) data words from the digital subsystem converted into ± 100 -volt analog signals are available on the analog problem board for insertion in analog problem loops. Flip-flop registers associated with each DAC can be independently up-dated as determined by the digital subsystem program. For simultaneous up-dating of all DAC's, an additional level of storage is available as an optional feature.

ANALOG-TO-DIGITAL DATA CHANNELS

Data channels on the analog problem board are multiplexed into an analog-to-digital converter. The ADC converts the varying analog signals (100 VFS) into 14-bit (plus sign) digital words.

A track and hold amplifier associated with the ADC eliminates errors due to changes in the analog signals during digitizing. For simultaneous data transfer, track and hold amplifiers on each multiplexer input are available as an option. Through the digital subsystem program the multiplexer can be randomly addressed or sequentially stepped. Combined random-sequential stepping and high-speed single-channel operation can also be used.

CONTROL LINKAGE

POTSET AND READBACK

Through the point selection capability in the analog subsystem, a data word from the digital subsystem can be used to select and read back through the ADC any of up to 10,000 points in the analog subsystem. Included are ampli-

fiers, potentiometers, multipliers, function generators, and other computing elements. An unloading amplifier is used so that high impedance outputs such as potentiometers can be read.

The digitally set reference divider, in conjunction with the above selection and readback capabilities, allows the digital subsystem to set potentiometers, read back the set value and compare it against the desired setting.

SIGNAL AND SENSE LINES

An important benefit of the control linkage is the ability of the digital subsystem to communicate discrete commands to the analog subsystem and to sense the state of logic elements in the analog subsystem.

The signal-line outputs are both wired directly to perform control of the analog subsystem, and are available on the logic patchboard of the analog subsystem. The direct-wired signal lines are used to switch the analog subsystem through its states such as standby, initial condition, compute, and hold. Signal lines terminated on the logic patchboard allow you the flexibility of patching them to perform special control, depending upon the individual problem requirements. In conjunction with patchable logic elements, such as flip-flops and relay drivers, they may be used to switch problem configuration and variables, and change scaling.

The sense lines give the digital subsystem the capability of making decisions based on information from the analog subsystem. They also allow the digital subsystem to check that operations are being performed as commanded.

INTERRUPT LINES

Interrupts allow the occurrence of events in the analog subsystem to modify the digital subsystem program. Outputs such as overloads and analog comparator outputs can be programmed to interrupt the computer, allowing it to take action such as changing analog problem scaling.

INTERFACE FEATURES

Transformer coupling of all data and control lines provides complete isolation of analog and digital grounds.

ANALOG INPUT CHANNELS (ADC):	20 standard, expandable.
SYSTEM INPUT RATE:	25,000 samples per second.
ANALOG OUTPUT CHANNELS (DAC):	20 standard, expandable.
SYSTEM OUTPUT RATE:	190,000 words per second, max.
SENSE LINES:	16 standard, expandable.
SIGNAL LINES:	16 standard, expandable.
PRIORITY INTERRUPTS:	16 standard, expandable.

DIGITAL SUBSYSTEMS

Beckman Integrated Computing Systems are available with any one of six SDS H-Series digital computers.

The SDS 92H provides real-time systems control, direct digital control, message switching, formatting and peripheral processing, and high-speed computation.

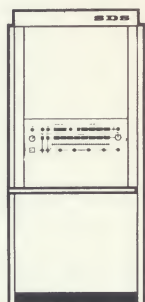
Input/output is compatible with that of SDS 900H Series computers so that the complete line of field-proven 900H Series peripheral equipment — including SDS MAGPAK — can be used without modification. And, like the SDS 900H Series computers, the 92H uses all-silicon semi-conductors. Advanced SDS logic design techniques result in the use of from two to five times fewer components than conventionally designed equipment. This gives the SDS 92H a significant reliability advantage over comparable computers.

The SDS 910H, 920H, 925H, and 930H are a family of compatible computers designed for scientific and engineering computation and for

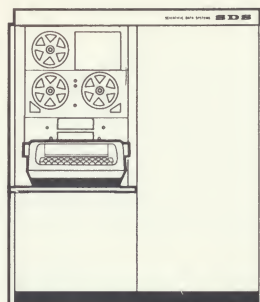
real-time systems integration. High internal computing speeds, powerful instruction lists, and a large number of efficient input/output systems insure maximum speed and flexibility for a wide variety of applications.

Each of these 900H Series computers meets a different range of requirements, but all four are compatible logically, electrically, and mechanically. Programs written for any 900H Series computer can be run on any other computer in the series. All 900H Series peripheral equipment can be used without modification on all four machines.

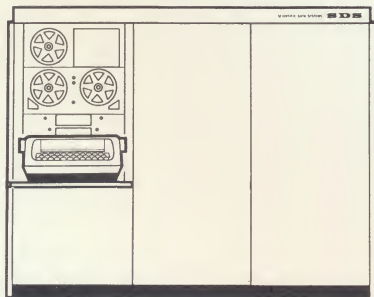
In the SDS 9300H, special attention has been given to features which facilitate integrating a computer into a real-time system. These include speed, flexible I/O, low component count for reliability, wide environmental tolerance, and small size. Real-time clocks, A-to-D converters, and displays are available as standard peripheral equipment.



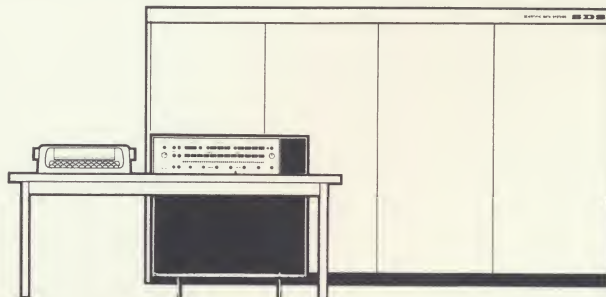
SDS 92H
Digital Subsystem



SDS 910H or SDS 920H
Digital Subsystems



SDS 925H or SDS 930H
Digital Subsystems



SDS 9300H Digital Subsystem

SPECIFICATIONS

TYPICAL FULLY EXPANDED ANALOG SUBSYSTEM

Total Amplifier Complement	392*
Integrator-Summer-High Gain	72†
Summer-High Gains	48†
Summers (Used for DFG's and Multipliers)	32
Inverters	
Diode Function Generators	32
Multipliers	96
Sin-Cos and Rate Resolver System	112
Potentiometers (Phase Compensated)	
2 Terminal (Digitally Set)	240
3 Terminal (Manually Set)	24
Spare Resistor Network (4 Inputs Each)	60
Electronic Multipliers (Digital or Quarter Square)	48
Electronic Sin-Cos and Rate Resolvers (Includes 4 Multipliers per channel not included in above 48 Multipliers)	8
Diode Function Generators	32
Function Switches	24
Comparator Amplifiers (Logic Output)	48
Function Relays	32
Electronic Switches	48
Noise Generator	1
Diode Limiters	
Feedbacks	32
Bridge Limiters (Off Board)	As Desired
Analog Patchboard	3600 Terminals
T-Trunks (To External)	240
P-Trunks (To Program Control Board)	16
Unassigned Trunks	80
Program Control Board Digital Logic Elements	
Schmitt/One-shots	4
RST Flip-flops	8
Inverters	8
Relay Drivers	16

Three-diode Networks	2
Logic Gates (3 Input)	6
Logic Gates (2 Input)	12
Electronic Switch Drive Lines	24
Comparator Outputs	24
Two-decade Preset Counters	4
Program Control Board	1196 Terminals
Q-Trunks (To External)	52
P-Trunks (To Analog Patchboard)	16
Unassigned	48
Patchable Digital Logic Module (Optional)	
Three-input Logic Gates	48
Schmitt/One-shots	8
Three-diode Networks	16
RST Flip-flops	16
Inverters	16
Four-bit Shift Registers	4
Status Lamp Drivers	
Assigned (Flip-flops, Comparators, Shift Registers)	56
Unassigned	16
Comparator Outputs	24
Electronic Switch Drive Lines	24
Two-decade Preset Counters	4
Logic Patchboard	1196 Terminals
Trunks to External	52
Trunks to Program Control Board	52
Unassigned	87

*Quarter Square Multipliers include two amplifiers per channel. For Digital or Quarter Square Multipliers with 3 amplifiers per channel, total is increased to 440 amplifiers.

†Integrator and Summer-High Gain analog patchboard layouts are identical. Additional Summer-High Gain Amplifiers can be installed initially and then expanded to Integrators in the field (up to 72).

DIGITAL SUBSYSTEM SELECTION CHART*

DIGITAL SUBSYSTEM	92H	910H	920H	925H	930H	9300H		
WORD LENGTH	12-bit	24-bit						
CORE MEMORY, MAXIMUM	32,000	16,000			32,000			
MEMORY CYCLE TIME	1.75 μ sec	8 μ sec		1.75 μ sec				
EXECUTION TIME	FIXED POINT Add	3.5 μ sec	16 μ sec	3.5 μ sec		1.75 μ sec		
	Multiply	285 μ sec†	248 μ sec	32 μ sec	54.25 μ sec	7.0 μ sec		
	FLOATING POINT††	Add		832 μ sec	368 μ sec	196 μ sec	83 μ sec	14 μ sec
			Multiply		1696 μ sec	600 μ sec	371 μ sec	138 μ sec

†Optional 7.0 μ sec Multiply Instruction. ††39-bit fraction, 9-bit exponent.

*SDS H-Series Digital Computers, including full Hybrid Software Packages, are available only in Beckman Integrated Computing Systems.

STANDARD HYBRID SOFTWARE PACKAGES

MODEL 2230/92H
With 4K to 32K Memory
SYMBOLIC ASSEMBLER
UTILITY PROGRAMS

MODEL 2230/900H
With Basic 4K Memory
UTILITY PROGRAMS
HYBRID FORTRAN II

MODELS 2230/910H, 920H, 925H
With 8K to 16K Memory*
UTILITY PROGRAMS
HYBRID FORTRAN II
HYBRID EXECUTIVE

MODEL 2230/930H
With 8K to 32K Memory*
UTILITY PROGRAMS
HYBRID FORTRAN II
HYBRID EXECUTIVE

MODEL 2230/9300H
With Basic 4K Memory
UTILITY PROGRAMS
HYBRID FORTRAN II

MODEL 2230/9300H
With 16K to 32K Memory*
UTILITY PROGRAMS
HYBRID FORTRAN II
HYBRID EXECUTIVE
HYBRID FORTRAN IV

*SDS MAGPAK and Card Reader also available

For further information on Beckman Hybrid Software, utilize the attached reply card to receive your copy of brochure C065539, "BECKMAN / FIRST IN HYBRID SOFTWARE." This software brochure offers more detail on the aforementioned programs, plus a description of how Beckman offers greater system control through priority interrupt structure, independent programming, and recursive subroutines.

BECKMAN HYBRID SOFTWARE

Beckman offers you the first standard software packages specifically developed for hybrid computation. With all Beckman Integrated Computing Systems — regardless of size — you are furnished a complete standard library of hybrid software — and at NO EXTRA COST! You are not burdened by the time-consuming task and high cost of developing specialized programs for your specific or varying applications.

PROGRAMMING SYSTEMS

HYBRID FORTRAN II

The Beckman hybrid computer, when incorporating either a 900 or 9000 Series SDS digital subsystem, utilizes Hybrid Fortran II. Special instructions to the computer, such as input or output commands and data specifications, use names or mnemonics easily associated with corresponding English terms. Expressions are used that are quite similar to accepted mathematical notations involving the operational relationships of constants, variables, and function.

As is the case with all Beckman hybrid programming systems, the generated code is completely compatible with interrupt operation. In the Hybrid Fortran II system many statements beyond the scope of normal Fortran are acceptable. These are listed below:

1. All ASA Fortran II standard definitions
2. Hybrid Fortran statements
For example:
Intra Computer Data Transfer
Computer Set Up and Check Out
Computer Mode Control
3. Logical Statements
These follow the ASA Fortran IV definitions and include:
AND, OR, NOT and Exclusive OR (EOR).
4. In-Line Symbol
By placing an "S" in column one, the statement is interpreted as Symbol and one line of machine code is generated.
5. Interrupt Connections
By use of the statements, Connect and Release, subroutines may be linked to and released from interrupt lines.

HYBRID FORTRAN IV

The HYBRID FORTRAN IV system, an extension of HYBRID FORTRAN II, allows you more flexibility in program implementation and features an improved language structure. The HYBRID FORTRAN IV compiler accepts a source program written in a language closely resembling ordinary mathematical notation. Designations such as complex variables and double-precision real-time variables eliminate the need for declaring the mode of a statement when writing the program. Also, decisions can be based on Boolean variables. Subroutines and functions may refer to storage arrays with dimensions, allowing flexibility in subprogram design and obviating recompilation to change dimension statements.

HYBRID EXECUTIVE

The HYBRID EXECUTIVE system automates the processing of intermixed programs, compilations, and executions with a minimum of operator intervention. The system utilizes magnetic tape units for recording of programming systems and utility systems.

Beckman hybrid software can be classified into two general categories: Programming Systems and Utility Systems. A programming system such as an assembler or compiler simplifies the programmer's task in specifying a sequence of operations for solving his problem. The Utility Systems aid in specific tasks, such as a program for automatically performing a static check of the analog subsystem of a hybrid calculation.

UTILITY SYSTEMS

A comprehensive library of UTILITY PROGRAMS is provided to insure you of efficient, economical use of the Beckman Integrated Computing System. These programs provide the benefits of ease of use, reduction of programming time, and automatic operation.

ANACHECK

This Fortran coded program performs AUTOMATICALLY a static checkout of the analog subsystem against a specified analog flow chart listing. This automatic checkout eliminates the need for the operator's time-consuming supervision of problem verification. ANACHECK not only checks patchboard wiring and function of computing elements, but indicates if proper contact is being made on all connections . . . AUTOMATICALLY.

REQUEST PACKAGE

A special feature of the Beckman Integrated Computing System is the Request Package. The last portion of core memory storage is allocated to a special program which allows you convenient access to the analog subsystem via the input/output typewriters.

This program permits a wide choice of monitor and control functions all of which can be controlled from the typewriter keyboard.

MAINTENANCE AND DIAGNOSTIC PROGRAMS

Each Beckman Integrated Computing System is provided with a set of programs designed to facilitate maintenance and pinpoint equipment malfunctions. These programs are tailored to meet the specific requirements of the equipment configuration involved. The programs are used during scheduled maintenance periods to insure that all elements are functional and operating within prescribed tolerances. These programs also can be used to speed the diagnosis and repair of system malfunctions.

Digital Subsystem — The Examiner System is a complete diagnostic package designed to exercise and/or diagnose the memory, digital computer logic, buffer, and associated peripheral equipment.

The Examiner System is composed of the following programs:

1. Memory Diagnostics Program
2. Instruction Diagnostics Program
3. Peripheral Diagnostics Program

Analog Subsystem — The Analog Subsystem Diagnostics package is designed to utilize the digital subsystem for program control and type-out of individual component failure. Program design allows you to perform checks on the entire complement of analog equipment automatically, or to select individual components or groups of components.

The system is composed of five diagnostic subprograms: (1) Amplifier, (2) Servo-set Potentiometer, (3) Electronic Multipliers, (4) Sin-Cos Function Generator, and (5) Electronic Comparators and Patchable Logic.

Beckman

INSTRUMENTS, INC.

COMPUTER OPERATIONS

2200 WRIGHT AVENUE
RICHMOND, CALIFORNIA • 94804
(415) 526-7730; TWX: 415-236-8933

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Technical Information Service

Gentlemen:
I would be interested in receiving additional information on:

- ☐ Beckman Integrated Computing Systems
- ☐ Beckman Analog Computers
- ☐ Beckman Software Brochure
- ☐ Your regular company mailing
- ☐ Have a Beckman Technical Representative call

This information required for:

- ☐ Immediate Procurement
- ☐ Future Procurement
- ☐ Reference Only
- ☐ A solution to my problem outlined below

Remarks _____

Name _____

Company _____

Address _____

State _____

Title _____

City _____

Zip _____



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